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# Escapement Numeration of *Oncorhynchus kisutch* in Chester Creek Anchorage, Alaska

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Alaska has numerous streams well known for their abundant salmon runs. However, in several Alaskan cities salmon populations have declined due to urbanization. An example of this would be Fish Creek (Milner & Oswood 2000) located in Anchorage, AK. Chester Creek in Anchorage, Alaska has followed this pattern. This small urban stream once supported several thousand salmon including *Oncorhynchus kisutch* (coho) and *Oncorhynchus gorbuscha* (pinks), but currently supports coho, rainbow trout, and dolly varden (Whitman 2002). It has been estimated that the adult coho population returning to Chester Creek ranged from 0-24 within the last two decades (Whitman 2002). No official counts of salmon escapement into Chester Creek have been accomplished. Chester Creek flows westward from the Chugach Mountains approximately 17 km running through the heart of Anchorage before emptying into Westchester Lagoon. The creek flowed directly into the Knik Arm portion of Cook Inlet prior to 1970. In 1970 the Municipality of Anchorage (MOA) established Westchester Lagoon by building a dam to create a recreational area. The lagoon sits in the southwestern portion of Anchorage, Alaska. Within the constraints of the dam a concrete weir (Figure 1) was built in an effort to support anadromous fish passage into the Chester Creek drainage. The weir also provided flow control and a sediment deposit area near the mouth of the stream (Davis & Muhlberg 2001).

Salmon populations were severely impacted due to the weir restricting anadromous fish passage into Chester Creek (Davis & Muhlberg, 2001). The design of the weir forced salmon to travel through two culverts 24 meters long. In order for the salmon to enter these culverts, the tide levels need to be within -1.25 to 1.19 meters of mean sea level (MSL) since fish avoid diving near stream entrances (USACE 2004) and have limited ability to leap into the culverts. These culverts are routed underground with a height difference of 12.50 m between the Knik Arm and the weir. Water leaving the lagoon falls approximately 3.66 meters and enters the culverts and is routed to the inlet. Coho's known maximum vertical leap is 2 meters (Sandercock 1991). This further limited successful escapement of coho and took away the mixing zone that would allow juvenile salmon returning to Cook Inlet to acclimate to saltwater. It was found that in order for the coho to successfully leap into the lagoon the incoming high tide had to reach approximately 8.53 meters.

Figure 1  Westchester weir that existed 1970-2008

Entrance into the weir from Westchester Lagoon was also hindered due to a front grating that was installed and blocked debris from falling into the culverts (Figure 2). The bars on the grating were spaced 15 to 20 cm apart. The debris consisted of a thick mat of vegetation growing at the water line

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and woody material from upstream. The size of the woody debris ranged from small sticks to logs 5.12 meters in length and 15- 20 cm in diameter. The buildup of debris over time also hindered successful escapement of coho. The stream corridor has been impacted by urbanization reducing water quality, stream channel alterations, erosion, and poor riparian zones. Healthy riparian zones are important to shade the stream and maintain water temperatures sufficient for salmon habitat (Madej, 2006). Riparian zones also provide allochthonous production required for salmon diets (Hetrick et al. 1998).

Figure 2  Grating showing debris.

In 1999, the Municipality of Anchorage (MOA) and U.S. Army Corps of Engineers proposed a two-phase process to restore the ecosystem of Chester Creek, Anchorage,

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Alaska (USACE, 2004). The first phase of this project removed the old weir and culverts. The new weir will be built in the northwest corner of the lagoon. The weir will allow anadromous fish to migrate into spawning habitat with greater ease. It will also allow juvenile salmon returning to sea to acclimate to saline marine conditions, thereby increasing survivorship. Phase II consists of creating a new channel from the weir to Cook Inlet. This new channel will meander for 473.4 meters with an elevation change of 6.5 meters with an average flow of 60 $ft^3/s$ and a depth of 0.8 ft. (Inter-Fluve Inc. 2008). Boulders, woody debris, and gravel will also be put in place to help with channel stability and provide habitat for aquatic species. The work is being accomplished in collaboration with MOA, Anchorage Waterways Council, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration (Habitat Restoration Center), and other contractors and volunteers.

Before the Chester Creek restoration project begins, the United States Fish and Wildlife Service (USFWS) requires baseline conditions to be known. To fulfill part of this requirement, salmon counts were conducted during July and August of 2008. Successful escapements were recorded when the salmon jumped and swam into Westchester Lagoon. The use of video cameras to accurately count salmon escapement was also examined. Video surveys have been shown to detect 87-98% of the fish (Otis and Dickinson, 2002). It is hypothesized that there will be no significant difference between visual and video counts allowing video counting a reliable source to estimate escapement numbers entering Chester Creek.

**Methods**

In order to complete salmon counts, two quantitative methods were employed: 1) visual counts made by five trained observers and 2) video camera recordings. Individuals were present at the weir two hours prior to high tide through two hours after high tide in order to setup camera equipment and observe incoming salmon. Successful escapement times and numbers were recorded in a logbook.

Two cameras (Toshiba Digital Color Camera; model IK-64WDA) were installed with a 5-40 optical power range. Cameras were placed in a weatherproof case manufactured by Pelco, Clovis, CA (model # EH3512). Tiffin circular polarizers mounted on the lenses reduced glare. Images were recorded on a Sanyo Digital Video Recorder (model # DSR-3506). Two sets of halogen lights were used during dark hours providing sufficient lighting requirements. Power supply for the video recording system and lighting was provided by a Honda generator (model EU2000i). The generator AC output was 120 volts, 2000 watts, and 16.7 amps. The digital recorder and generator were housed in an old weather station box. A tub was placed under the generator in the event of an oil or gas spill.

One camera was placed on the side of the west wing wall using a metal pipe rock bolted to the wall (Figure 3). The camera faced in a downstream direction focusing on the left portion of the weir 3.4 meters away from the weir waterfall ledge. The second camera was installed on the top center of the weir pointing downward focusing on the right side of the weir 3 meters above the ledge. It was attached using u-bolts to grating placed on top. Both sets of lights were placed on top of the weir pointed downward towards the water at angle to reduce glare.

Total number of coho escapements visually counted were summed and compared to totals that were counted by watching video. A chi-square test was run to

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determine if a significant difference occurred between visual and video counts. A linear regression was used to determine if video counts can significantly account for the visual counts. Cooks distance was used to determine if outliers had an undue effect on the regression. All analyses were accomplished using SPSS for Windows v. 15. Alpha level was set to $p < .05$.

Figure 3 Camera attached to weir.

**Results**

Observations occurred during a 42-day period starting on July 22 and ending on September 2nd. Several fish were first seen on July 22nd but no successful escapements. The first successful escapements occurred on July 30th. The highest high tide during that period was 9.97 meters and the lowest was 7.25 meters (NOAA

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2008). There were 497 coho visually counted that successfully escaped and 394 were counted using video. This resulted in no significant difference between visual and video counts = 33.30, p = .05). Assumptions for the regression model were not met with two outliers outside of ± 2 standard deviations. However, Cooks distance was less than 1 indicating the outliers had no undue effect on the model. The regression model showed a significant improvement over the mean ($F_{1, 35}$ = 1333.41, p = .00). The regression slope ($t_{35}$ = 36.52, p = .00, Table 1) is significantly different than zero indicating that the video counts (observed) can predict the visual counts (expected).

Table 1- The slope is significantly greater than zero indicating that video counts can predict the visual counts would be ($t_{35}$ = 36.52, p = .00).

**Coefficients**[a]

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | .189 | .621 | | .305 | .762 | -1.072 | 1.450 |
| | Video counts | 1.244 | .034 | .987 | 36.516 | .000 | 1.175 | 1.313 |

a. Dependent Variable: Visual counts

Video counts accounted for 98% of the visual counts ($R^2$ = .98, Table 2).

Table 2 - $R^2$ = .98 indicating that 98% of the visual counts are accounted for using video counts.

**Model Summary**[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics: R Square Change | Change Statistics: F Change | Change Statistics: df1 | Change Statistics: df2 | Change Statistics: Sig. F Change |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| .987[a] | .975 | .974 | 2.977 | .975 | 1333.406 | 1 | 34 | .000 |

a. Predictors: (Constant), Video counts

b. Dependent Variable: Visual counts

## Discussion

The abundance of salmon that successfully escaped was much higher than originally thought. Weir design, broken fish ladder, and previous anecdotal observations had led us to expect fewer than 100 coho successfully escaping into the lagoon. If the debris wasn't cleaned out prior to the start of this project, it is believed that there would have been fewer successful escapements. It is unknown if MOA had a schedule to keep the debris cleaned out in the past. If the debris wasn't cleaned out, especially prior to the salmon run, it may have contributed to past low escapement estimates.

The method of using a video camera is a good predictor of the expected or visual counts. This is concluded since 98% of the variability in visual counts could be explained by video counts (Table 2, Figure 4). The other 2% are explained by chance. These results support the hypothesis that there is no significant difference between visual and video counts. Figure 5 shows a daily comparison of visual and video escapement numbers. An 80% success rate using video counts was calculated from Figure 5.

Although the difference between the total visual and video counts seems high (103), the chi-square determined there was no significant difference between the total daily observations of the two modes of counting. The regression model then looks at differences on each day of observations. The variability in the differences is small allowing us to obtain a linear regression value.

Reliable power supply was a key aspect using video technology. The generator

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was chosen for this project due to time and cost constraints as well as aesthetics in the highly visited recreational area. If this type of project were to continue, a solar powered system would be optimal for supplying power. Since Westchester Lagoon is a high visibility area we felt that the solar panel would be vandalized rendering the video system inoperable. Additionally, since this was only occurring during one season, establishing a solar powered system didn't seem economically feasible. Technical issues with the generator did cause two days of no video. Human error also caused another day of missing video. Noise levels of the weir drowned out the generator noise (~ 59 db).

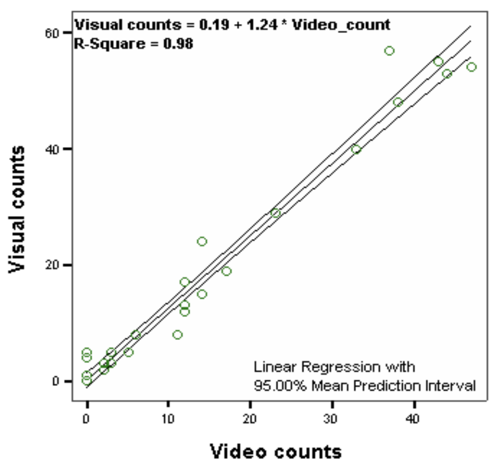


Figure 4 – 98% of the visual counts are explained using video counts. The equation, Visual counts = .19 + 1.24*Video count can be used to make the prediction.

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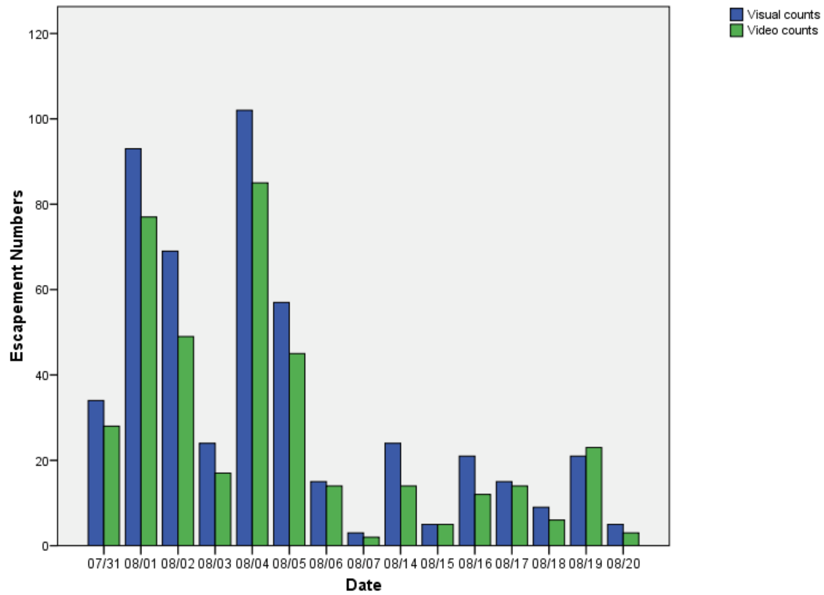


Figure 5 – Daily comparison of visual and video counts showing an 80% success rate using video counts.

An ideal situation to count salmon escapement would have been at a location further upstream near other culverts. This would have included a v-shaped weir to allow salmon to pass through upstream avoiding the possibility of double counting. However, MOA declined our request to put scientific equipment into the stream. It was possible to have double counted salmon escaping at the weir since there was no equipment installed to prevent any salmon swimming back through the weir. However, during observation times, no salmon were noted returning back through the weir.

The new weir will be constructed with a built in capability of housing a camera system and will be wired to supply an electrical source for future fish monitoring (HDR 2008). Other improvements for future monitoring consist of a support rack to house cameras, recorders, lights, and framing to hold white-board that will increase the

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contrast of passing fish. The option of using a contrasting background was examined for this project but do to safety and a limitation set by MOA its use was not granted.

After the construction of the new weir, coho and other fish will be able to migrate into the Chester Creek drainage with greater ease. Juvenile survivability should increase with a mixing zone present and improved habitat around the mouth of Chester Creek. Similar small streams in Oregon have had an average of 40% annual increase (House 1996). Katz (2007) suggests that for a restoration project to be effective, winter and spring habitat areas also need to be restored as well as a more natural migration of fish. Once the restoration of the mouth of Chester Creek is complete, efforts should be exerted toward habitat improvements near the headwaters.

Overall the goals of this project were achieved; however, several improvements could have made this project a greater success. Measurements of the tide flux within the weir would be useful in determining the exact water levels required in order for the coho to successfully escape. Water temperature and turbidity levels in Cook Inlet may have shown a correlation in these parameters and the run timing. Recent studies also suggest examining air pressure, stream discharge, and precipitation amounts in determining run timing of salmon (Keefer et al. 2004).

**Habitat Survey and Minnow Traps**

A habitat inventory for Chester Creek was conducted using a combination of methods from Bisson et. al. (1982), Overton et. al. (1997), and the EPA's Environmental Monitoring and Assessment Program (EMAP) protocols for wadeable streams (www.epa.gov/). This habitat survey will be used to estimate the carrying capacity of Chester Creek. A report on this work will be ready in

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 8/13/08 | 61°12.495' N | 149°55.409' | Westchester Weir | | | 2 | | | |
| 3 | 8/13/08 | 61°12.495' N | 149°55.409' | Westchester Weir | | | | | | |
| 4 | 8/13/08 | 61°12.495' N | 149°55.409' | Westchester Weir | | | 9 | | | |
| 5 | 8/13/08 | 61°12.495' N | 149°55.409' | Westchester Weir | 10 | | 19 | | | |
| 1 | 8/13/08 | 61°11.551' N | 149°49.774' | King Career Center/Mallard | 7 | | | | | 6-14 cm |
| 2 | 8/13/08 | 61°11.551' N | 149°49.774' | King Career Center/Mallard | 3 | | | | | |
| 3 | 8/13/08 | 61°11.551' N | 149°49.774' | King Career Center/Mallard | 1 | | | | | |
| 4 | 8/13/08 | 61°11.551' N | 149°49.774' | King Career Center/Mallard | 23 | 2 | | | | |
| 5 | 8/13/08 | 61°11.551' N | 149°49.774' | King Career Center/Mallard | 3 | | 1 | 1 | | |
| 1 | 8/13/08 | 61°11.069' N | 149°48.477' | University Lake Outlet Footbridge | 11 | 1 | 1 | | | 5-15 cm |
| 2 | 8/13/08 | 61°11.069' N | 149°48.477' | University Lake Outlet | 6 | | | | | |
| 3 | 8/13/08 | 61°11.069' N | 149°48.477' | University Lake Outlet | 11 | | 2 | | | |
| 4 | 8/13/08 | 61°11.069' N | 149°48.477' | University Lake Outlet | | | | | | |
| 5 | 8/13/08 | 61°11.069' N | 149°48.477' | University Lake Outlet | 4 | | | | | |
| 1 | 9/2/08 | 61°11.092' N | 149°48.667' | UAA Lightpost 1 | 13 | 3 | | | | 10-14 cm |
| 2 | 9/2/08 | 61°11.071' N | 149°48.770' | UAA Lightpost 8 | 22 | | | | | 8-12 cm |
| 3 | 9/2/08 | 61°11.044' N | 149°48.475' | UAA Lightpost 9 | 24 | 2 | | | | 6-15 cm |
| 1 | 9/2/08 | 61°11.105' N | 149°48.441' | University Lake Outlet Footbridge | 20 | | | | | 7-13 cm |
| 2 | 9/2/08 | 61°11.131' N | 149°48.029' | University Lake Beaver Lodge | 21 | 6 | 4 | | | 4-8 cm |
| 3 | 9/2/08 | 61°11.147' N | 149°47.802' | University Lake Inlet | 24 | | | | | 6-9 cm |
| 1 | 9/2/08 | 61°11.075' N | 149°47.607' | Post University Lake FootBridge | | | | 2 | | 9-11 cm |
| 2 | 9/2/08 | 61°11.105' N | 149°47.579' | Fence Bend Bridge to Wesleyan | 4 | | | | | 5-7 cm |
| 3 | 9/2/08 | 61°11.127' N | 149°47.542' | Wesleyan Culvert | 15 | 2 | 1 | 2 | | 15 cm |
| 1 | 9/17/08 | 61°11.953' N | 149°50.112' | Lake Otis  Ball Fields | water drop left trap dry | | | | | |
| 2 | 9/17/08 | 61°11.973' N | 149°50.460' | Lake Otis & 24th | 7 | | 58 | | | |
| 3 | 9/17/08 | 61°12.063' N | 149°51.541' | E. 20th Footpath | 2 | | | | | 7-8 cm |
| 4 | 9/17/08 | 61°12.285' N | 149°53.922' | Arctic USGS Gaging | 3 | | | | | 7-8 cm |
| 5 | 9/17/08 | 61°12.244' N | 149°54.208' | Eastchester Park | 16 | | 1 | | | 2-10 cm |
| 1 | 9/23/08 | 61°12.499' N | 149°43.153' | Northview & E. 16 | 2 | | | | | |
| 2 | 9/23/08 | 61°12.568' N | 149$^{o4}$4.038' | Muldoon & DeBarr | 3 | 7 | | 1 | | |
| 3 | 9/23/08 | 61°12.155' N | 149$^{o4}$4.903' | Sherwood & Patterson off E. 20th | 25 | 1 | | 1 | | |
| 4 | 9/23/08 | 61°11.846' N | 149°45.628' | Behind Baptist Temple | 3 | 24 | | | | |

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December of 2009.

One last aspect of the summer of 2008’s work was to set minnow traps to assess the presence of coho in different parts of Chester Creek.  The data collected are summarized in the following Excel spreadsheet.  More detailed data were presented in the ADF&G FRC permit holder’s data form.

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